

CABLE ARRANGEMENT OF CEILING FAN

FIELD OF INVENTION

- 5 The invention pertains to a cable arrangement of a ceiling fan. More particularly, the invention relates to the cable arrangement of a ceiling fan with closely positioned cables.

10 BACKGROUND OF THE INVENTION

- Ceiling fans typically have a main printed circuit board and a motor printed circuit board that are stored within a fan hub, wherein the main printed circuit board is accommodated within a housing that is located above the motor. Generally, the main
15 printed circuit board comprises two printed circuit board layers, one of which is used for directing power from an external power source into the ceiling fan, and another is for converting the voltage of the power into a suitable voltage to be supplied to the components of the fan. Therefore, the main printed circuit board is located near to the ceiling to ease connection of the power cable between the main printed circuit board
20 and power source. On the other hand, the main printed circuit board is linked to the motor printed circuit board that is attached on the motor below the main printed circuit board through a motor cable.

- Such configuration of the printed circuit boards and motor allows electromagnetic
25 compatibility (EMC) as the power cable and motor cable are not positioned close to each other, therefore preventing the occurrence of electromagnetic interference. However, with the two printed circuit board layers of the main printed circuit board being positioned one atop another and separated at a distance, the housing of the main printed circuit board needs to be in a considerable size, thereby increasing the overall

size of the fan hub.

To solve electromagnetic interference issues, US3215768A revealed the use of a cable having at least one electrical wire, a first electro-magnetic shielding layer surrounding
5 the wire, and a second shielding layer concentric with the first layer. The first layer is fabricated of a magnetic material having relatively low permeability and relatively good conductivity, whereas the second layer being fabricated of a magnetic material having relatively high permeability. Both the shielding layers are made of braided wire and preferably have their wire elements meshed as tightly as possible.

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On the other hand, WO2006135135A1 disclosed a coaxial cable structure for connecting to a printed circuit board. A plurality of coaxial cables are adapted for transmitting data to the printed circuit board, wherein each coaxial cable has a signal
15 line for transmitting data to the printed circuit board, an inner insulator covered along the outer periphery of each signal line, a shield wire covered along the outer periphery of the inner insulator for shielding the plurality of signal lines from one another, and an outer insulator covered along the outer periphery of the shield wire to form an outer layer of each signal line. Particularly, the signal line and the shield wire of each of a plurality of coaxial cables are exposed to the outside at both ends thereof and is
20 directly soldered to a pattern part formed on the printed circuit board, without having any separate connector. The pattern part has a ground pattern adapted for providing ground contacts.

Both US3215768A and WO2006135135A1 addressed electromagnetic interference
25 issues by targeting the configuration, material, and structure of the cable. However, these documents provided no information on electromagnetic interference solutions to reach electromagnetic compatibility that is targeted for a ceiling fan, especially a compact ceiling fan, that involves arrangement of the cables, power circuit boards and other components of the ceiling fan.

SUMMARY OF INVENTION

In an aspect of the invention, there is provided a ceiling fan that comprises a downrod suspended from a ceiling; a housing mounted to the downrod, and enclosing at least a portion of the downrod; a motor housed within the housing; and a circuit assembly positioned within the housing including a motor printed circuit board connected to the motor; a main printed circuit board; a power cable connecting the main printed circuit board to a power supply; and a motor cable connecting the main printed circuit board to the motor printed circuit board to provide power to the motor; wherein the motor cable and power cable are placed in close proximity to each other, with the power cable or motor cable including wires that are at least partially insulated by a conductive shield having one of its ends connected to a ground of the motor printed circuit board or main printed circuit board.

Preferably, the ceiling fan further comprises a connector where the end of the shield is inserted into a pin of the connector to be connected to the ground.

It is preferred that the wires of the motor cable or power cable are connected to the connector.

In a preferred embodiment, the shield encloses wires that are twisted around one another.

According to the preferred embodiment, the shield is braided.

Furthermore, the motor cable or power cable may comprise a non-conductive tube as an outermost layer of the cable.

In addition, the main printed circuit board is positioned below the motor.

Based on a preferred embodiment, the housing includes a divider that separates the motor and main printed circuit board.

- 5 In a preferred embodiment of the invention, the motor cable and power cable run through the downrod.

Preferably, the main printed circuit board includes any one or a combination of a means for directing power from the power supply, a means for converting voltage of
10 power, and a remote control signal receiver.

These aspects of the invention offer a ceiling fan with electromagnetic compatibility, especially when the power cable and motor cable are placed close to each other. It is an object of the invention to provide a compact ceiling fan with a reduced size fan hub
15 through combining the two printed circuit board layers of a main printed circuit board into one layer of main printed circuit board, or placing the two printed circuit board layers in close proximity to each other, such that the power cable and motor cable are positioned near to each other without electromagnetic interference issues. Such ceiling fan also ensures safety for use. In addition, the invention offers solution in the
20 arrangement of the cables with respect to the components of the ceiling fan such that they can be neatly organized and arranged in a way that reduces length of the cables. Further, it is also an object for the ceiling fan to have unnecessary spaces eliminated.

One skilled in the art will readily appreciate that the invention is well adapted to carry
25 out the objects and obtain the ends and advantages mentioned, as well as those inherent therein. The embodiments described herein are not intended as limitations on the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

For the purpose of facilitating an understanding of the invention, there is illustrated in the accompanying drawings the preferred embodiments from an inspection of which
5 when considered in connection with the following description, the invention, its construction and operation and many of its advantages would be readily understood and appreciated.

Fig. 1 shows an internal view of the ceiling fan.
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Fig. 2 shows a preferred embodiment of the cable having a shield surrounding the wires.

Fig. 3 shows a preferred embodiment of the motor cable that connects the main
15 printed circuit board to the motor circuit board.

Fig. 4 shows a preferred embodiment of the main printed circuit board.

Fig. 5 shows the motor cable and power cable connected to the main printed circuit
20 board.

DETAILED DESCRIPTION OF THE INVENTION

25 Hereinafter, the invention shall be described according to the preferred embodiments of the present invention and by referring to the accompanying description and drawings. However, it is to be understood that limiting the description to the preferred embodiments of the invention is merely to facilitate discussion of the present invention and it is envisioned that those skilled in the art may devise various

modifications without departing from the scope of the appended claim.

Disclosed herein is a ceiling fan suspended from a ceiling via a downrod **100**. An upper canopy **220** may be provided at upper portion of the downrod **100** to enclose the joint portion between the downrod **100** and the ceiling. A housing **200** which may be a lower canopy, that defines a fan hub is mounted at lower portion of the downrod **100**. The housing **200** encloses at least a portion of the downrod **100** and houses a motor **300**. Other than the motor **300**, the housing **200** also accommodates a circuit assembly that comprises a motor printed circuit board **410** connected to the motor **300**, a main printed circuit board **420**, a power cable **421** connecting the main printed circuit board **420** to a power supply, and a motor cable **411** connecting the main printed circuit board **420** to the motor printed circuit board **410** to supply power to the motor **300**.

The main printed circuit board **420** may include any one or a combination of a means for directing power from the power supply, a means for converting voltage of power, and a remote control signal receiver. An exemplary embodiment of the ceiling fan is shown in **Fig. 1** where the ceiling fan has a compact size housing **200** by having one layer of main printed circuit board **420**. The one layer of main printed circuit board **420** combines a first printed circuit board layer that is responsible for directing power from an external power source, and a second printed circuit board layer that converts the voltage of the power into a compatible voltage for components of the ceiling fan. Optionally, the first printed circuit board layer and second printed circuit board layer are separate layers but placed adjacent to each other.

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In this embodiment, the housing **200** includes a divider **210** that separates the motor **300** from the main printed circuit board **420**. Preferably, the main printed circuit board **420** is positioned below the motor **300**. The motor printed circuit board **410** may be directly attached onto the motor **300**.

The power cable **421** extends, preferably through the ceiling, from the external power source to reach the ceiling fan. In the ceiling fan, the power cable **421** runs through the downrod **100** to be connected to the main printed circuit board **420**. In **Fig. 1**, the upper portion of the power cable **421** that extends from the ceiling into the downrod is not shown. On the other hand, the motor cable **411** has one end connected to the main printed circuit board **420**, and another end connected to the motor printed circuit board **410**. Similarly, the motor cable **411** runs through the downrod **100** to link the main printed circuit board **420** and motor printed circuit board **410**. Since a portion of both the power cable **421** and motor cable **411** are disposed within the downrod **100**, they are in close proximity to each other as shown in **Fig. 1**.

According to **Fig. 2**, the power cable **421** and motor cable **411** each comprise one or more wires **430** therewithin that are preferably twisted around one another. The wires **430** of either and both the power cable **421** and motor cable **411** are at least partially insulated by one or more conductive shield **440** to keep the cable **411**, **421** with the shield **440** from electromagnetically interfering another cable **411**, **421** or electrical components of the ceiling fan. The shield **440** may be formed of braided strands of conductive material such as copper, aluminium, and the like. Alternatively, the shield **440** may be a non-braided spiral winding of metal tape, or a layer of conducting polymer. The cable example shown in **Fig. 2** has one shield surrounding two intertwined wires **430** with a strand of the conductive material extending from the shield **440**. A non-conductive tube **460** such as a polyvinyl chloride (PVC) tube and cross-linked polyethylene (XLPE) tube is used to encapsulate the shield **440** and wires **430** as the outermost layer of either or both the motor cable **411** and power cable **421**.

Each wire **430** of the motor cable **411** and power cable **421** may be connected to the motor printed circuit board **410** and main printed circuit board **420** respectively through connection means like solder or connector **450**. The connector **450** comprises

a plurality of pins **451** to receive the wires **430** respectively for establishing a connection between the wires **430** and the printed circuit boards **410**, **420**. One of the ends **441** of the shield **440** which may be the distal end **441** of the shield **440** in the form of a strand of the shield **440**, is connected to a ground of the corresponding printed circuit board **410**, **420**. In a preferred embodiment of the invention where a connector **450** is used for connecting the wires **430** with the printed circuit board **410**, **420**, the end **441** of the shield **440** is inserted into a pin **451** of the connector **450** to be connected to the ground.

Fig. 3 depicts an example of motor cable **411** that comprises two layers of shields **440**, namely a first shield **440a** and a second shield **440b** enclosing a plurality of wires **430** of the motor cable **411**. The pores on the first shield **440a** may allow the wires **430** to be in contact with the second shield **440b**. A non-conductive tube **460** is applied as the outermost layer of the motor cable **411**. Each wire **430** of the motor cable **411** extends out of the non-conductive tube **460** to be inserted into an available pin **451** of the connector **450**. In the preferred embodiment of the motor cable **411** shown in **Fig. 3**, the wires **430** at the end of the motor cable **411** that is adjacent to the main printed circuit board **420** is connected to one connector **450**, whereas the wires **430** at another end of the motor cable **411** that is adjacent to the motor printed circuit board **410** are divided into two groups where each group of wires **430** are connected to separate connectors **450**, namely the first connector **450a**, and the second connector **450b**. The end **441** of the shield **440** that is to be connected to a ground of one of the printed circuit boards **410**, **420** can be inserted into the connector **450** adjacent to the main printed circuit board **420**, or either the first connector **450a** or second connector **450b** that is adjacent to the motor printed circuit board **410**.

Fig. 4 illustrates an exemplary main printed circuit board **420** and shows the position where the connector **450** is located for the motor cable **411** to be connected thereto and extend towards the motor printed circuit board **410**. In a preferred embodiment of

the invention with the end **441** of the shield of the cable **411**, **421** being connected to the ground of the main printed circuit board **420** through the connector **450**, the pin **451** of the connector **450** where the end **441** of the shield **440** is connected thereto, is linked to an earthing route of the main printed circuit board **420** for grounding purpose.

It shall be understood that to eliminate or reduce electromagnetic interference, either the power cable **421** or the motor cable **411** can be included with the shield **440** and connected to the ground of its corresponding printed circuit board **410**, **420**.
10 Optionally, the shield **440** can be applied to both the power cable **421** and motor cable **411** and connected to the ground of its corresponding printed circuit boards **410**, **420**. Should the power cable **421** contain at least a shield **440**, the end **441** of the shield **440** to be connected to a ground of the main printed circuit board **420** is connected to a pin **451** of the connector **450** of the main printed circuit board **420**.

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Fig. 5 illustrates a preferred embodiment of the invention whereby the motor cable **411** has its wires **430** encapsulated by the shield **440**, and the end **441** of the shield **440** is inserted into a pin **451** of the connector **450** that is connected to an earth point of the main printed circuit board **420**. The power cable **421** is also connected to the
20 main printed circuit board **420**.

The present disclosure includes as contained in the appended claims, as well as that of the foregoing description. Although this invention has been described in its preferred form with a degree of particularity, it is understood that the present disclosure of the
25 preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangements of parts may be resorted to without departing from the scope of the invention.

CLAIMS

1. A ceiling fan comprising
 - a downrod (100) suspended from a ceiling;
 - 5 a housing (200) mounted to the downrod (100), and enclosing at least a portion of the downrod (100);
 - a motor (300) housed within the housing (200); and
 - a circuit assembly positioned within the housing including
 - a motor printed circuit board (410) connected to the motor (300);
 - 10 a main printed circuit board (420);
 - a power cable (421) connecting the main printed circuit board (420) to a power supply; and
 - a motor cable (411) connecting the main printed circuit board (420) to the motor printed circuit board (410) to provide power to the motor
 - 15 (300);
 - wherein the motor cable (411) and power cable (421) are placed in close proximity to each other, with the power cable (421) or motor cable (411) including wires (430) that are at least partially insulated by a conductive shield (440) having one of its ends (441) connected to a ground of the motor printed
 - 20 circuit board (410) or main printed circuit board (420).
2. The ceiling fan according to claim 1, further comprising a connector (450) where the end (441) of the shield (440) is inserted into a pin (451) of the connector (450) to be connected to the ground.
- 25 3. The ceiling fan according to claim 2, wherein the wires (430) of the motor cable (411) or power cable (421) are connected to the connector (450).

4. The ceiling fan according to any one of the preceding claims, wherein the shield (440) encloses wires (430) that are twisted around one another.
5. The ceiling fan according to any one of the preceding claims, wherein the shield (440) is braided.
6. The ceiling fan according to any one of the preceding claims, wherein the motor cable (411) or power cable (421) comprises a non-conductive tube (460) as an outermost layer of the cable (411, 421).
7. The ceiling fan according to any one of the preceding claims, wherein the main printed circuit board (420) is positioned below the motor (300).
8. The ceiling fan according to any one of the preceding claims, wherein the housing (200) includes a divider (210) that separates the main printed circuit board (420) and the motor (300).
9. The ceiling fan according to any one of the preceding claims, wherein the motor cable (411) and power cable (421) run through the downrod (100).
10. The ceiling fan according to any one of the preceding claims, wherein the main printed circuit board (420) includes any one or a combination of a means for directing power from the power supply, a means for converting voltage of power, and a remote control signal receiver.